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| 09/653,561 | 08/31/2000 | Larry Hillyer | M4065.0239/P239 | 5354 |

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| EXAMINER |
|---|
| NGUYEN, HA T |

| ART UNIT | PAPER NUMBER |
|---|---|
| 2812 | |

DATE MAILED: 02/12/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

| Office Action Summary | Application No. 09/653,561 | Applicant(s) HILLYER ET AL. | |
|---|---|---|---|
| | Examiner Ha T. Nguyen | Art Unit 2812 | |

*-- The MAILING DATE of this communication appears on the cover sheet with th correspondence address --*

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

1)☒ Responsive to communication(s) filed on *25 November 2002* .

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

4)☒ Claim(s) *1-4,6-18,20-31,34-39,41-50 and 52-97* is/are pending in the application.

4a) Of the above claim(s) *45-49* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-4,6-18,20-31,34-39,41-44, 50 and 52-97* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

**Application Papers**

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

**Priority under 35 U.S.C. §§ 119 and 120**

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

**Attachment(s)**

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

## DETAILED ACTION

### *Notice to applicant*

1. Applicants' Amendment and Response to the Office Action mailed 7-31-02 has been entered and made of record (Paper No. 11).

### *Response to Amendment*

2. In view of Applicants' cancellation of the claims, the rejection of claims 19, 32, 40, and 51 under 35 U.S.C. 102 or 103 has been rendered moot.

In view of Applicants' amemdment to the claims, the rejection of claims 15, 25, and 26 under 35 U.S.C. 112 second paragraph, as being indefinite, has been withdrawn.

Applicants' arguments with regard to the rejections under 35 U.S.C. 102 or 103 have been fully considered, but they are not deemed to be persuasive for at least the following reasons.

Applicants argued mainly that Smith (U. S. Patent 6277733) teaches away from using conventional $O_2$ plasma to strip photoresist. The examiner disagreed, even though Smith discloses when there is a possible "exposed Cu at the bottom of the via, this approach is generally not used" (see col. 1, lines 60-62), the reason is to avoid excessive formation of Cu oxide, this principle also applies for the metals that can be easily oxidized listed in col. 2, lines 26-32. However, Smith still uses $O_2$ plasma to clean polymer on the sidewalls of via when the oxidation is not excessive, a reduction step is performed to reduce the metal oxide (see Fig. 1 and col. 4, lines 35-67). In the case of the claimed inventions, there is no presence of a metal sensitive to oxidation by oxygen, $O_2$ plasma is usable, therefore Smith does not teach away from the use of $O_2$ plasma .

Applicants also argued that the combination of Smith with Kawai (USPN 6284664) is not proper because Smith teaches away from using $O_2$ while Kawai teaches the use of a mixture of $CF_4$ and $O_2$. The examiner disagreed, Smith also teaches the use of $CF_4$ and $O_2$ and as explained above, Smith stil uses $O_2$ when there is no excessive oxidation of the metal present at the bottom of the via, this applies to the case of the claimed invention which does not require the presence of such a metal.

Applicants also argued that Smith does not disclose the use of a "plasma generated from a gas consisting essentially of ammonia". The examiner disagreed, even though Smith discloses the use of plasma of hydrogen, it also discloses the use of plasma of other hydrogen containing

gas like $NH_3$ or $CH_4$ or plasma of a combination of hydrogen containing gases. Smith does not expressly teach "gas consisting essentially of ammonia", but this is implied, because when ammonia is substituted for hydrogen, the plasma is ammonia plasma which is understood to consist "essentially" of ammonia, in the same way, the Applicants' specification discloses ammonia plasma to mean plasma consisting essentially of ammonia. Therefore, Smith does teach the use of a plasma consisting essentially of ammonia.

Applicants also argued that Smith only use $O_2$ plasma to remove photoresist. The examiner disagreed, after $O_2$ plasma or hydrogen containing plasma is used to remove the photoresist, Smith teaches that a plasma of $O_2$ and $CF_4$ (or other fluorocarbon) is used to clean up residues (see col. 4, lines 35-67). This means that $O_2$ plasma is used for cleaning up. The claims do not preclude the use of $O_2$ plasma in combination with plasma of other gases. Therefor, Smith's teaching still meet the limitations of the claims.

Applicants also argued that neither Smith nor Kawai teaches the use of plasma generated from a hydrogen containing gas in the absence of added oxygen. Smith discloses subsequent to the exposure to a $O_2$ plasma, a plasma of hydrogen or hydrogen containing gas. No oxygen is added to the hydrogen containing gas (see col. 5, lines 1-17), the main reason for using this step is to reduce metal oxide, it would be self defeating if oxygen is added to the hydrogen containing plasma of this step. Therefor, Smith does teach the use of hydrogen containing gas in the absence of added oxygen.

Notes: Even though the examiner attempted to treat the claims individually, however, because of the time limitation and the very large number of claims and associated claimed features, error in grouping may occur. Applicants are advised to focus more on the rejection of the subject matters rather than the grouping of the claims.

### *Claim Rejections - 35 USC § 102*

3. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless --
>
> (e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who

has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371© of this title before the invention thereof by the applicant for patent.

4. Claims 1-4, 14, 54-57, 66, 70-73, and 82 are rejected under 35 U.S.C. 102(e) as being unpatentable by Smith ( U. S. Patent 6277733).

[Claims 1, 54, and 70] Referring to Figs. 1, 2a-2h and related text, Smith discloses a method for removing polymer etch residue from an etched opening in a semiconductor wafer device comprising: forming an opening 429 in an insulating layer, wherein a polymer etch residue remains within said opening after the opening forming step (see Fig. 2d and col. 4, lines 8-26); contacting said opening with a plasma to remove said polymer etch residue, said plasma generated from a gas consisting essentially of ammonia, $H_2$, or $CH_4$ (see col. 4, lines 8-26); the examiner interprets that inherently some residues are also removed;

[Claims 2, 55, and 71] wherein said opening is a HAR contact opening (see Fig. 2f);

[Claims 3, 56, and 72] wherein said contacting is performed under conditions effective to remove said etch residue without substantially increasing the size of said opening (See col. 1, 54-56);

[Claims 4, 57, and 73] wherein said opening is contacted with ammonia, $H_2$, or $CH_4$ gas in the absence of oxygen (See col. 4, lines 8-48);

[Claims 14, 66, and 82] further comprising forming a conductive layer at the bottom of said opening following said contacting step (see col. 5, lines 33-42).

### *Claim Rejections - 35 USC § 103*

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was

commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103© and potential 35 U.S.C. 102(f) or (g) prior art under 35 U.S.C. 103(a).

6. Claims 6-13, 16-18, 21-23, 24, 27, 28, 58-65, 74-81, and 86-88 are rejected under 35 U.S.C. 103(a) as being unpatentable over Smith.

Smith discloses substantially the limitations of claims 6-13, 16-18, 21-23, 24, 27, 28, 58-65, 74-81, and 86-88, as shown above.

[Claims 16 and 86-88] contacting said opening with an oxygen containing plasma; stopping said oxygen plasma contacting before said polymer etch residue is completely removed and thereafter contacting said opening with a second plasma generated from a hydrogen containing gas (see col. 3, lines 36-47) ; wherein said hydrogen containing gas is ammonia, hydrogen, or methane gas (see col. 4, lines 8-26), it would have been obvious for a person of ordinary skill in the art to stop the oxygen plasma treatment before the occurrence of an excessive oxidation of the exposed metal at the bottom of the opening, inherently some residues still remain;

[Claim 17] the arguments for the rejection of claims 2 and 3 apply;

[Claim 18] the arguments for the rejection of claims 4, 57, and 73 apply;

[Claims 6, 20, 58, and 74] It also discloses wherein said contacting is done at a temperature within the range of about 250-500C (See col. 4, lines 33-43 ); and

[Claim 22] wherein said second contacting is performed at a temperature of about 350C (see col. 4, lines 8-48).

But Smith does not disclose the parameters for the ammonia, $H_2$, or $CH_4$ plasma contacting step. However any variation in parameters in the present claims is obvious in light of the cited art, because the changes in parameters produce no unexpected function.

The routine varying of parameters to produce expected changes are within the ability of one of ordinary skill in the art. Patentability over the prior art will only occur if the parameter

variation produces an unexpected result. In re Aller, Lacey and Hall, 105 U.S.P.Q. 233, 235. In re Reese 129 U.S.P.Q. 402, 406.

Therefore, it would have been obvious to use the teaching of Smith to obtain the invention as specified in claims 6-13, 16-18, 21-23, 24, 27, 28, 58-65, 74-81, and 86-88.

7. Claims 29-31, 34-38, 41-44, and 89-91 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kawai in view of Smith.

[Claims 29-32, and 89-91] Referring to Figs. 3A-3D, Kawai discloses a method of forming a contact opening in a semiconductor device, comprising: etching a contact opening 22 in an insulative layer 18 in said device down to a polysilicon14 element of said device; removing the photoresist; contacting said opening with an oxygen plasma to inherently remove a portion of said etch residues;and cleaning etch residue from said etched opening by contacting said opening with a gas (see abstract col. 4, lines 4-58). But it does not disclose expressly the use of oxygen plasma to remove photoresist, the use of [Claims 29, 89-91] ammonia, hydrogen, or methane gas for cleaning etch residue and [Claim 30] wherein said contacting is performed under conditions effective to remove said etch residue without substantially increasing the size of said opening; [Claim 31] wherein said contacting is performed under conditions which do not oxidize said opening; [Claim 32] where said opening is contacted in the absence of added oxygen . However, the missing limitations are well known in the art because Smith discloses these features (See col. 4, lines 8-48 and col. 1, 54-56). A person of ordinary skill is motivated to modify Kawai with Smith to obtain a more effective polymer residue cleaning etch.

[Claim 41 ] wherein an insulating layer 18 is formed on said device prior to said etching and said etching forms a contact hole in said insulating layer;

[Claims 42-44] wherein in said etching is dry etching; wherein said dry etching is performed using at least one fluorine containing gas; and wherein said fluorine-containing gas is at least one gas selected from the group consisting of $CH_2F_2$, $CHF_3$, $C_2F_6$, $C_2HF_5$, and $CH_3F$ (see col. 4, lines 8-18).

[Claims 34-38] the arguments similar to the rejection of claims 6-13, 21-23, 24, 27, 28, 58-65, and 74-81 apply.

Therefore, it would have been obvious to combine Kawai with Smith to obtain the invention as specified in claims 29-32, 34-38, 41-44, and 89-91.

8. Claims 1, 2, 15, 25, 26, 39, 50-53, 67-69, 83-85, and 92-97 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kawai in view of Smith and Hamada.

[Claims 1, 2, 15, 25, 26, 39, 50, 51, 53, 67-69, 83-85, 92, 94, 95, and 97] Referring to Figs. 3A-3D, Kawai discloses a method of forming an integrated circuit structure comprising: forming an insulating layer 18 over a polysilicon region 14; forming a contact opening in said insulating layer down to said polysilicon region using a fluorine containing gas (see col. 4, lines 4-18); removing polymer residue from said contact opening using a gas (see col. 4, lines 26-58). But it does not discloses that the contact opening has HAR, the steps of removing polymer residue with plasma essentially of ammonia, hydrogen, or methane gas, forming a titanium silicide at the bottom of said opening in contact with said polysilicon layer; forming a conductor in said opening in electrical contact with said silicide; and using said gas to remove polymer residue after using oxygen plasma; wherein said second plasma contacting is performed for a period of time sufficient to remove said residue from a bottom of said opening ; wherein said bottom of said opening is not oxidized during said second plasma contacting, and said contact does not substantially increase the size of the opening. However, the missing limitations are well known in the art because Smith discloses substantially all the missing limitations as shown above; wherein said second plasma contacting is performed for a period of time sufficient to remove said residue from a bottom of said opening (see col. 4, lines lines 8-48); wherein said bottom of said opening is not oxidized during said second plasma contacting step (see col. 4, lines 8-48); and Hamada discloses forming a titanium silicide 111 at the bottom of said opening in contact with said polysilicon layer 104; forming a conductor 112 in said opening in electrical contact with said silicide (see Fig. 3D and col. 5, lines 1-20);.

[Claims 52, 93, and 96] further comprising removing a portion of said polymer residue from said contact opening with oxygen;

A person of ordinary skill is motivated to modify Kawai with Smith and Hamada to obtain good cleaning and improved connection conductivity.

Therefore, it would have been obvious to combine Kawai with Smith and Hamada to obtain the invention as specified in claims 1, 2, 15, 25, 26, 39, 50-53, 67-69, 83-85, and 92-97.

***Conclusion***

9. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for response to this final action is set to expire THREE MONTHS from the date of this action. In the event a first response is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event will the statutory period for response expire later than SIX MONTHS from the date of this final action.

10. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Ha Nguyen whose telephone number is (703)308-2706 . The examiner can normally be reached on Monday-Friday from 8:30AM to 6:00PM, except the first Friday of each bi-week.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, John Niebling, can be reached on (703) 308-3325. The fax phone number for this Group is (703) 308-7722.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Group receptionist whose telephone number is (703) 308-0956.

Ha Nguyen
Primary Examiner
02-06 - 03